Educational objectives

Upon completion of this course, participants should be able to achieve the following:

1. Understand the need for core buildups in restorative dentistry.
2. Understand the differences between self etch and total etch bonding.
3. Be able to explain the clinical aspects of the core buildup procedure.
4. Understand the reasons for a flowable composite liner in core buildups.
5. Understand the need for core buildups in periodontal tissue management.

Introduction

Following caries removal, the clinician is often faced with restoring a preparation that contains undercuts, unsupported tooth structure and is highly irregular in shape. Further, the cut dentin provides a direct pulpal pathway by disrupting the peripheral seal, allowing for the inward transport of bacteria and other irritants that contribute to post-operative sensitivity as well as long-term pulp damage.

Indirect restoration of such teeth, especially when caries is extensive, requires an improved substrate that is mechanically and biologically stable. Accordingly, what is needed is a preliminary “restoration within a restoration” that sets up the case for a successful outcome.

The bonded core buildup fulfills this requirement, giving the clinician greater control in restoring broken down teeth.

In this article the author reviews the reasons for placing bonded core buildups, and describes use of dual cured and light cured composite materials in the core buildup procedure.
Mechanical Advantages of Bonded Cores

The core buildup procedure replaces lost tooth structure prior to preparing for an indirect restoration, thus giving the clinician the means to address mechanical undercuts, unsupported tooth structure and an irregular substrate, thus creating a more idealized prep design. Accordingly, the restoration becomes more predictable from a mechanical perspective. There are many other advantages to placing core buildups prior to cast dentistry as delineated by Strupp:

Preservation and strengthening of tooth structure. Unsupported areas of the preparation create weak areas under a casting that can result in fracture of the dentin substrate and failure of the restoration. The bonded composite resin core buildup creates a uniform substrate that serves as a more stable foundation and better fit for both the provisional and the final restorations.

Fewer path of insertion/draw problems. This highly practical consideration becomes apparent during chairside fabrication of provisional restorations. The core buildup eliminates intracoronal undercuts, so fabrication of provisional restorations becomes easier. The improved path of draw is also important in reducing drag and distortion during impression making, since obstructions that may have existed due to the loss of tooth structure from caries have been eliminated.

Easier laboratory procedures. Wax patterns are much less likely to distort and dies are much less likely to break with the elimination of intracoronal undercuts. The core builds allow for more uniform metal and porcelain substructures that are more likely to remain dimensionally stable during the heating and cooling phases of laboratory fabrication. Further, a precious metal casting that is thinner uses less gold, thus reducing the cost of the restoration.

Better retention and fit. By creating a more regular preparation the core buildups impart an improved retention to the case. In today’s world of adhesive dentistry, this becomes less critical than when conventional cements were used, however retention remains an important factor during the provisionalization phase of treatment. Proper contours of the preparations reduce the likelihood of the distortion of the material in an undercut while in its plastic state. Further, the operator is less likely to leave an open margin that would promote dissolution of the temporary cement and lead to post-operative complications.

Reduced use of posts. One risk with posts is that those that are conventionally cemented do not strengthen teeth; rather their function is only to retain the core buildup. Since dentin bonding has become more reliable, many clinicians have found a substantially reduced need for post placement. Prior to the advent of dentin bonding, severely broken down endodontically treated teeth required the additional retention provided by an intra-canal post since these clinical cases had insufficient undercuts for mechanical retention of the core. The unintended consequence in some cases was a weakened root and subsequent fracture under normal function. A post can lead to a vertical or apical fracture of the root as well as increased difficulty and cost for endodontic retreatment.

Biologic advantages of bonded cores. Pain-producing stimuli have been shown to produce fluid shifts within the dentinal tubules and are directly correlated with the permeability of dentin. Composite core builds utilize dentin adhesives to create an interphase layer between the bonding resin and the cut dentin that reduces the permeability of the dentin by restoring the peripheral seal. Accordingly, this hybrid zone serves as a barrier to the conduction of bacteria and toxins toward the dental pulp as well as to fluid movement within the dentinal tubules. Indeed, this hybridization of the exposed dentin is currently considered the most effective way of protecting the pulp-dentin interface. As a result, many clinicians have found that post-operative sensitivity as well as post-insertion root canals are substantially fewer in number since bonded core builds have gained wide acceptance.

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Bonding Strategy:
Total Etch vs. Self Etch

Dentin bonding can be accomplished by either removing the smear layer, or by maintaining it as the bonding substrate. The first system, called “Total Etch” treats enamel and dentin simultaneously, and is characterized by a preliminary application of 32-40 percent phosphoric acid. These total etch systems work by opening the dentinal tubules, increasing dentinal permeability and decalcifying the intertubular and peritubular dentin. In fact, these total etch systems rely on the complete removal of the smear layer and smear plugs, thereby making the tubules available for resin tag formation. The cut dentin becomes a soft, organic surface with unsupported collagen fibrils that collapse when air dried, and risk the material undergoing phase changes if left too wet. Accordingly, the precise control of surface moisture is necessary to avoid loss of bond strength and post-operative sensitivity even though evaluating what is “too wet” or “too dry” varies between operators and between materials.

The other method called “Self Etch” does not decalcify the dentin surface with phosphoric acid, rather these products infiltrate the intact smear layer and make it part of the hybrid zone. Self-etching systems simultaneously condition and prime the dentin, thus eliminating the decalcification of total etch systems. These self etch products are designed for use on dry dentin, thus eliminating the technique sensitivity of trying to maintain the correct surface moisture that characterizes total etch systems. From a clinical standpoint, achieving a uniformly dry surface is much more predictably accomplished than achieving a uniformly “moist” one.

One self-etching system (Clearfil Protect Bond, Kuraray) has been further developed to include two functionalized components. The first is an antibacterial component within the hydrophilic primer that disinfects the cut dentin surface, thus decreasing the potential for bacterial conduction to the pulp. The second is a fluoride component within the hydrophobic resin that is suggested to contribute to the long-term stability of the resin-dentin bond.

Requirements for Core Buildup Materials

In order that a core buildup material will function as replacement dentin, it needs to have similar physical properties as dentin while remaining biologically compatible with the host. Its compressive strength, flexural strength and tensile strength must be comparable to the underlying dentin so to prevent a materials failure under function. In addition, its hardness should be close to that of dentin to that the material’s resistance to cutting with rotary instruments gives the operator the same tactile feedback as when cutting tooth structure.

Core buildup materials need to handle well with minimal slumping during placement as well as have an appropriate setting time. They also need to be bonded securely with an adhesive whose bond strength exceeds the contraction force exerted by the core material as it polymerizes so to prevent de-bonding and gap formation. Further, the bond strength of the core to the substrate must be sufficient to resist dislodgment during preparation, impression making, provisionalization, and long-term function.

There are three basic groups of composite materials used today in core buildups: self-cured, light-cured and dual-cured, each of which can accomplish the stated objectives. Different core materials are available to accommodate many different placement techniques, and it is the operator’s choice as to which is most suitable. The author’s preferences include light cured and dual cured materials since they are both photosensitive and thus offer more control of the polymerization reaction.

Light-cured Core Buildup Technique: Preparation

In this case, a core buildup was planned for tooth #30 to serve as a restoration until a casting can be placed [Fig. 1 page 54]. A distal-occlusal composite for tooth #29 was performed simultaneously, although with an aesthetic composite (Clearfil Majesty Esthetic, Kuraray) not a core buildup material.

Following satisfactory local anesthesia, (Citanest) and rubber dam isolation, the technique for core placement began with the removal of old restorations and recurrent caries [Fig. 2 page 54] using a 330 bur (TriHawk) on a high-speed handpiece to section the old restorations. An outline form and initial caries removal was accomplished with the 330 bur, then as in all restorative dental procedures, the preparation checked for decay with caries staining solution (Caries Detector, Kuraray). Residual decay was excavated with a #4 round bur on a slow speed handpiece with continuous irrigation to avoid trauma from the frictional heat generated by the bur.

As a general comment, the operator must take precautions to avoid pulpal exposure, and if the caries is encroaching on the pulp, then a smaller bur (#2 round) should be used without irrigation (for better visualization) to remove the last traces of decalcified dentin. In an asymptomatic tooth, it is the author’s preference to leave the pulp intact even if there is slight staining still present. The residual stain from the solution does not interfere with adhesion, and so the bonding procedure can nonetheless be safely completed. The final preparation was then created using a shoulder-forming diamond that is available in three different lengths (Pollard Dental, F62, F82, or F102). The completed preparation was cleaned with coarse pumice to remove debris, then rinsed.

Clean and Dry Field

Proper isolation is mandatory when applying the adhesive and the core buildup material. Accordingly, the use of a matrix band or if tissue is bleeding, then the placement of retraction cord (#7 Silstrax Pascal Company) soaked in Hemodent solution (Premier) is often useful. The use of the Hemodent is itself a compromise...
as it can interfere with the self-etch primer, so it is imperative that the operator rinse the solution from the tooth within a few seconds. If the operator is unable to isolate the field properly, then periodontal treatment is required, and a temporary core buildup is needed until tissue health can be established. Durelon, a polycarboxylate cement that is free of eugenol handles easily by creating a putty-like mix, and is effective in providing a temporary filling of the preparation until the case can be completed. Once the soft tissues are controlled through perio surgery or more conservative means, then the Durelon is removed and the composite core buildup is placed in the usual manner.

**Light-cured Adhesive and Restorative Material**

The bonding agent selected needs to be compatible with the core material used. In the case of a light-cured restoration, a light-cured, self-etching adhesive with antibacterial and fluoride-containing properties was chosen (Clearfil Protect Bond, Kuraray) that disinfects the smear layer of cut dentin that will become part of the hybrid zone. The primer was applied in a single coat and left in place for 20 seconds. After the substrate was completely air-dried, the microfilled bonding resin was applied [Fig. 3], lightly aired, then cured 20 seconds with a standard curing lamp. This fluoride-containing bonding agent has been shown to exhibit in vivo bonding strength of 18 MPa, with no degradation found after one year. 10

Prior to placing the composite core buildup, the author employed the preliminary use of a thin layer of light-cured, heavily filled flowable composite resin for improved surface wettability and surface adaptation [Fig. 4]. Another benefit of using a liner of flowable composite is its elastic capabilities, especially in a thin layer11, that buffer the polymerization shrinkage stress by flow, which in theory would eliminate gap formation, cusp deformation, and reduce microleakage. 11 Similar chemistry between the hybridized layer and the flowable composite resin helps to generate an excellent bond between the two surfaces.10

The flowable material was applied over the entire cut dentin surface with a ball burnisher to exert maximum control over the composite. The flowable composite chosen (Clearfil Majesty Flow, Kuraray) is a flowable composite with a high filler content (81wt%) that imparts high strength similar to regular hybrid composites, coupled with minimal polymerization shrinkage.

Following the photo-polymerization of the flowable composite liner, a second application is then used that is left unset until the heavy bodied light-cured core material (Clearfil Photo Core, Kuraray) was placed and contoured in segments. This combination of a liner of flowable composite followed by the curing of the increments separately results in less contraction stress being transferred to the margins of the preparation during photoactivation thus decreasing the chance of either cusp deflection or gap formation. The core buildup material (Clearfil Photo Core, Kuraray) was chosen because its heavy consistency makes for easy handling, it has a cure depth of up to 8mm and is one of the few light-cured core materials on the market. Once the core buildup was completed, attention was given to the adjacent tooth (#29) which was restored in a similar manner [Fig. 5] using the same selfetching adhesive, coupled with a flowable composite liner, and an aesthetic, nano-hybrid composite (Clearfil Majesty Esthetic).

In the second case [Fig. 6], the light-cured material was used to restore a large carious defect in an upper canine that resulted from uncontrolled torque from an old upper partial denture. This defect was of such a size [Fig. 7] that its presence precluded the planned fixed bridge that would span from #6 to #8 after extracting #7 until it could be first restored. The procedure was similar to the previous case in that a self-etching adhesive (Clearfil Protect Bond) was first employed followed by
a liner of flowable composite (Clearfil Majesty Flow) and finally the light-cured core buildup material (Clearfil Photo Core). In this situation, the extensive carious destruction of the canine tooth would otherwise create an unmanageable clinical problem because of the severely weakened state of the remaining tooth structure as well as the undercut that would cause distortion throughout the entire impression making and laboratory procedures.

Once the decay was removed and the tooth isolated, the procedure began with the application of the self-etch primer (Clearfil Protect Bond, Kuraray) that was allowed to remain on the dentin surface for 20 seconds, then dried. Next, the resin bonding agent was applied in a single coat, lightly aired, then light-cured [Fig 8]. A liner of flowable composite was placed over the cut dentin and then light-cured. Next, the packable composite core material (Clearfil Photo Core, Kuraray) was dispensed into the preparation in small increments [Fig 9], contoured and light-cured.

Once the preparation was built out to more than full contour, the tooth that was scheduled for removal (#7) was reduced to the tissue margin to facilitate easier fabrication of the provisional bridge [Fig 10]. The abutment preparation was then completed, the hopeless tooth #7 was removed, and the provisional bridge cemented with Durelon cement. After 10 weeks, the impression was made, and two weeks later the final bridge was inserted with resin cement [Fig. 11].

### Dual-Cured Adhesives and Restorative Materials

Another widely used system of core buildup materials consist of Dual-Cured Composites that combine a catalyst and base after which the polymerization reaction is started by photoactivation. In the following case, [Fig. 12] a quadrant of teeth was planned for restorative cast dentistry owing to recurrent caries. Since there were relatively short clinical crowns and encroachment on biological width, periodontal surgery was planned in conjunction with the restorative dentistry.

Once old restorations were removed [Fig. 13] caries debridement was completed after staining with Caries Detector Solution [Fig. 14] and the case then prepared for placement of the core buildups [Fig. 15 page 58]. The Dual-Cured adhesive (Clearfil DC Bond, Kuraray) was mixed according to directions, applied to the substrate, air-dried, then light-cured. Then the Dual-Cured composite core material (Clearfil DC Core Automix, Kuraray) was applied using the automixing tip in the extruder system. Once deposited into the preparation, the polymerization reaction was initiated with the halogen light (20 seconds per tooth) and then allowed to sit undisturbed for seven minutes to allow for the material’s complete polymerization. Following initial crown preparation [Fig. 16 page 58] and provisionalization, the patient was referred for periodontal surgery.

After 12 weeks, the patient exhibited excellent tissue health, thus enabling the rapid completion of the case [Fig. 17 page 58].

### Endodontically Treated Teeth

Prior to dentin bonding, severely broken down endodontically treated teeth required a post and core as part of the restoration largely because there was no other way other than using the canal space to secure the buildup material into the preparation. The root canal provided a channel to obtain a snug fit and cementation surface for the post that retained the core and facilitated the fabrication of a better fitting casting.

One type of post procedure requires the use of a stock post that is cemented into the prepared canal space, generally performed with a drill that corresponds in size. These post channels required enlargement of the endodontic space with a series of drills, the last one providing a channel that allowed for a snug fit of the fit-
ting of the post. Other pre-formed systems involve threading the prepared post space and torquing the post into place. Conventional cements were used to cement posts in the earlier days, later replaced by dentin bonding cements.

Another type of post procedure involves a direct procedure where the clinician fabricates an acrylic post/core pattern chairside, then in the laboratory, casts up the one-piece, post/core assembly that is cemented in place. The same procedure can be done indirectly where an impression is made of the prepared post space and a gold post/core assembly is then laboratory fabricated. This procedure has been further refined by using corresponding drills and pre-fabricated plastic burnout patterns that are lifted out in an impression from which a working model is made, and the final casting created. High gold alloys were necessary to avoid the dark roots that resulted from corrosion of the less noble metals. This was the author’s preferred technique for post/core buildups until the advent of dentin bonding.

There are problems that clinicians sometimes experience with posts. Many systems were designed with a large diameter that greatly weakened the root, often leading to vertical fractures, periradicular infection, and loss of the tooth. A similar problem occurred with the screw-type posts that created potentially destructive torque forces within the root that also led in many cases to the tooth’s eventual removal. Endodontic retreatment became more complicated as well, with the need to remove a cemented post necessitating further loss of tooth structure and potential breakage.

Since posts do not strength teeth, and merely retain the core, dentin bonding will enable the clinician to restore endodontically treated teeth without jeopardizing the integrity of the root. Posts also do not eliminate the need for appropriate crown length, and failure to allow for the proper ferrule will result in a catastrophic failure with or without a post.

The preferred treatment is to approach the restoration intracoronally and extra-coronally. With a minor modification of the routine core buildup procedure, the clinician will obtain a regular, sturdy substrate onto which a cast restoration for the endodontically treated tooth can be reliably placed. Secondly, the clinician must be attentive to the periodontal status of the preparation, such that adequate ferrule is present, and there is no encroachment upon the biologic width. Ironically, many clinicians attempt to use posts to solve these restorative challenges, which often result in split roots and failure.

Following endodontics, all remaining caries, restorations and bases are removed, and the chamber examined [Fig A]. The objective is to create a solid foundation for a cement base that will serve as an additional protective barrier to any potential microleakage that may develop after the crown is cemented and to maintain the integrity of the apical seal of the root canal. Using a surgical length, #2 round bur, the each canal orifice is prepared 1-2 mm below the chamber floor level. Then, the entire preparation is scrubbed with ethyl alcohol [Fig B] to remove any eugenol residue, rinsed, and dried.

Then, a loose mixture of zinc phosphate cement is prepared on a frozen glass slab, loaded into a needle tip syringe (Centrix) and deposited into the chamber.12 The cement is allowed to remain for 7-10 minutes until it is fully set [Fig C]. The core is then placed in the usual manner.

Discussion

Each of the aforementioned simplified core buildup techniques utilizes a self-etching adhesive that reduces (or most frequently eliminates) post-operative sensitivity by the maintenance of the smear plugs during the hybridization of the self etch adhesive.10
Accordingly, the clinician avoids the potentially problematic decalcified dentin surface and increased dentin permeability that occurs during the phosphoric acid etching. The light-cured procedure avoids gap formation (caused by polymerization shrinkage) at the resin-dentin-restoration interfaces by the following:

2. Excellent bond between the highly filled flowable liner and the hybridized zone.
3. Incremental layering of light-cured composite and simultaneous curing of a second layer of flowable with the packable composite.

The dual-cured core material flows, unlike the heavy bodied light cured Photo Core, and so the intermediate layer of flowable composite is not necessary to get good adaptation to the cut dentin surface. Further, the polymerization reaction in the dual cure material takes place more slowly than does the light-cured material, thus reducing the strain at the dentin interface.

The light cured technique is widely used because of the speed and ease with which the cores can be placed especially when there are relatively few at a time, since they can be cured rapidly. Despite the substantial cure depth that is possible with this material, the author still prefers an incremental technique so to reduce further the effects of any polymerization shrinkage as well as to provide maximum control when using the material.

After the core buildup is bonded in place, the comparable hardness of this material to dentin becomes an important aspect to the process, since a material’s tendency to cut like dentin will enhance the clinician’s tactile ability to create the desired preparation. Accordingly, the clinician can create the geometric internal form of the classic gold preparation if desired, or the less retentive, dome-shaped design that is made possible by using bonded cements.

Conclusion

The placement of bonded core buildups prior to indirect dental procedures greatly improve clinical outcomes by enabling the clinician to create a substrate that is mechanically and biologically stable for long-term success. Dual cure and light cure composite resin core materials coupled with compatible self-etching adhesives comprise a simplified, effective strategy for the operator to create well-fitting, predictable cast dentistry.

Bibliography

Post-test

1. One biologic reason to do a core buildup prior to preparing a cast restoration is to:
   a. Eliminate undercuts
   b. Increase dentin permeability
   c. Restore the peripheral dentin seal
   d. Create a uniform substrate

2. Provisional restorations fit better with a core buildup:
   a. Because the master die model is less likely to break
   b. Because the material does not distort from an intracoronal undercut
   c. Because acrylic provisional do not bond to composite
   d. Because with a core, there is less likelihood of long-term pulp damage

3. Bonded core buildups reduce postoperative sensitivity by:
   a. Increasing dentin permeability
   b. Creating a hybrid zone that functions as a barrier to tubule fluid movement
   c. Increasing the incidence of fluid shifts within the tubules
   d. Their functioning with a cast post within the canal space

4. Intracanal posts
   a. Are needed less since the advent of bonded core buildups
   b. Can complicate endodontic retreatment
   c. Increase the risk for a vertical or apical root fracture
   d. All of the above

5. The Total Etch Technique
   a. Removes the smear layer
   b. Increases dentin permeability
   c. Requires a precise control of dentin moisture content
   d. All of the above

6. The issue of a "too wet or too dry" dentin substrate is
   a. Relevant when using a self etch technique
   b. A factor when placing all core buildups
   c. An evaluation that varies between operators and between materials
   d. Not important when using a total etch technique

7. Polycarboxylate cement as a temporary core material is suggested
   a. Because it does not contain eugenol that might interfere with subsequent bonding
   b. When the tissues are bleeding and satisfactory isolation is not possible to perform dentin bonding
   c. Because of its ease in handling
   d. All of the above

8. The physical property of a core material that affords the operator with the tactile feedback of dentin when using a high speed handpiece to prepare for the final casting is a function of its
   a. Compressive strength
   b. Hardness
   c. Tensile strength
   d. Flexural strength

9. Caries Detector Solution:
   a. Does not interfere with bond strength of overlying composites
   b. Should be used whenever caries debridement takes place
   c. Should not be removed where there is a danger of a place of pulpal exposure in the absence of pulpal symptoms
   d. All of the above

10. Relative to a gold casting:
    a. The core buildup facilitates the fabrication of one with a more uniform thickness
    b. The core buildup increases the precious metal cost
    c. The classic geometric preparation design is mandatory when a core buildup is used, irrespective as to the kind of luting cement
    d. None of the above

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